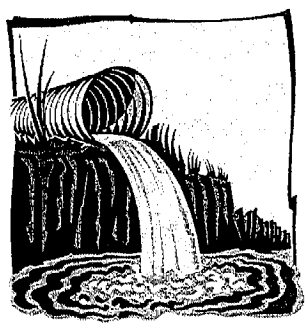
5. PESTICIDES



5. PESTICIDES

5.1 SUMMARY

Pesticides, including diazinon and chlorpyrifos, have been identified by CALFED as contaminants of concern in both the Central Valley and Delta. These pesticides have been shown to exceed known toxic levels to sensitive organisms. Pesticide concentrations may alter the abundance and distribution of aquatic species. Inability to prevent toxicity caused by these pesticides could impair full restoration of the ecological integrity of Central Valley rivers and the estuary.

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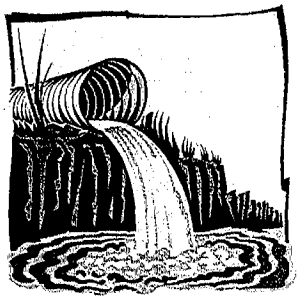
The proposed approaches to address pesticide problems include conducting toxicity and chemical monitoring, TIEs, hazard assessments, MPs, and effectiveness assessments. Diazinon and chlorpyrifos are not the only pesticides addressed in this section. The purpose of this section is to establish a methodology by which toxicity linked to current pesticide usage can be eliminated. The actions taken and planned for toxicity associated with diazinon and chlorpyrifos usage will act as a general pattern for other pesticide toxicity cases that arise. The Parameter Assessment Team also identified carbofuran as a pesticide that needs to be studied. Section 11 of this report, "Toxicity of Unknown Origin," includes methods for toxic constituents, which could include pesticides.

5.2 PROBLEM STATEMENT

Certain pesticides have been identified in surface waters of the Bay-Delta estuary and its watersheds at levels that are reported to impair aquatic life beneficial uses.

Current scientific knowledge is not adequate to determine the ecological significance or spatial and temporal extent of the impairments.



5.3 OBJECTIVE

The objective is to manage pesticides through existing regulatory agencies and voluntary cooperation of pesticide users such that the beneficial uses of the waters of the Bay-Delta and its tributaries are not impaired by toxicity originating from pesticide use.

5.4 PROBLEM DESCRIPTION

5.4.1 Diazinon and Chlorpyrifos

Surface waters in the Central Valley and Delta estuary have repeatedly tested toxic in bioassays. In some instances, diazinon and chlorpyrifos have been identified as the principal cause of toxicity. In other cases, the chemical cause of toxicity was not identified.

Toxicity from diazinon and chlorpyrifos has been detected in surface water during winter and early spring from applications on orchards, during summer from irrigation return water, and during both winter and summer in urban runoff samples.

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Orchards

Toxicity testing of the estuary began in the late 1980s. Numerous bioassay and chemical studies have identified the organophosphate insecticide diazinon in surface water samples in the Central Valley during winter at concentrations toxic to sensitive invertebrates. Concern has been expressed that contaminants other than diazinon also might be present in winter storm runoff from the Central Valley and might contribute to invertebrate bioassay mortality. Therefore, TIEs were conducted on samples testing toxic in *Ceriodaphnia* bioassays from the Sacramento and San Joaquin Rivers. The results confirm that diazinon was the primary toxicant.

Irrigation Return Water

Chlorpyrifos toxicity was detected on nine occasions in surface water from four agriculturally dominated backwater sloughs in the Delta estuary. In each instance, the *Ceriodaphnia* bioassay results were accompanied by modified Phase I and II TIEs and chemical analysis that implicated chlorpyrifos. On four additional

occasions, Phase III TIEs were conducted. These confirmed that chlorpyrifos was the primary chemical agent responsible for the toxicity in these samples. Analysis of the spatial patterns of toxicity suggests that the impairment largely was confined to backwater sloughs and was diluted away after tidal dispersal into main channels. The precise agricultural crops from which the chemicals originated are not known because chlorpyrifos is an agricultural insecticide that is commonly applied during the irrigation season. However, the widespread nature of chlorpyrifos toxicity, at least in March 1995, coincided with applications on alfalfa and subsequent large rainstorms. Further monitoring is needed to conclusively identify all sources.

Urban Runoff

Ceriodaphnia bioassay mortality has been reported in urban creeks of Sacramento and Stockton, including Morrison Creek, Mosher Slough, 5-Mile Slough, the Calaveras River, and Mormon Slough—all within the legal boundary of the Delta. A TIE conducted on samples from each site revealed diazinon and chlorpyrifos. Chemical analyses demonstrated that diazinon and occasionally chlorpyrifos were present at toxic concentrations. *Ceriodaphnia* bioassay results, coupled with TIEs and chemical analysis from the Bay Area, suggest that diazinon and chlorpyrifos may be a regional urban runoff problem.

5.4.2 Extent of Impairment

Orchards

The highest concentrations of diazinon and longest exposures are typically in small water courses adjacent to high densities of orchards. However, after the large storms of 1990 and 1992, diazinon was measured in the San Joaquin River at the entrance to the Delta at toxic concentrations to the *Ceriodaphnia dubia* in EPA three-species bioassays. Following up on these findings, the USGS and CVRWQCB traced pulses of diazinon from both the Sacramento and San Joaquin Rivers across the estuary in 1993. Toxic concentrations to *Ceriodaphnia* were observed as far west in the estuary as Chipps Island, some 60 miles downstream of the City of Sacramento.

The highest concentrations of diazinon and longest exposures are typically in small water courses adjacent to high densities of orchards.

Diazinon is present in urban-dominated creeks around the City of Sacramento and Stockton after winter storms, as is discussed below. However, background concentrations of diazinon in urban stormwater runoff increased after application on orchards in January and February, suggesting that urban use is not the sole source of the chemical at this time. Volatization following application is known to be a major diazinon dissipation pathway from orchards, and a number of

dormant spray insecticides have previously been reported in rain and fog in the Central Valley. Composite rainfall samples collected in south Stockton in 1995 demonstrated that diazinon concentrations in rain varied from below detection to about 4,000 nanograms per liter (ng/l) (10 times the acute *Ceriodaphnia* concentration). The rainfall study was continued through March and April 1995 to coincide with application of chlorpyrifos on alfalfa for weevil control. Chlorpyrifos concentrations in composite rainfall samples increased, ranging from below detection to 650 ng/l (again, 10 times the acute *Ceriodaphnia* concentration). However, unlike diazinon, no study was conducted to ascertain whether chlorpyrifos concentrations in street runoff increased.

Irrigation Return Water

In 1991 and 1992, a bioassay study was conducted in agriculturally dominated waterways in the San Joaquin River Basin to determine the extent of toxicity. Chlorpyrifos was detected on 190 occasions between March and June of both years, 43 times at toxic concentrations to *Ceriodaphnia*. Many of the crops grown in the San Joaquin River Basin also are cultivated on Delta tracts and islands. It was unknown whether these same agricultural practices might also contribute to in-stream toxicity in the Delta. Follow-up studies were conducted as part of the SWRCB Bay Protection Program. Chlorpyrifos was periodically identified at toxic concentrations in backwater sloughs, suggesting that the same impairments occur in the Delta as in the San Joaquin River Basin.

Urban Runoff

Detailed information on urban sources of diazinon and chlorpyrifos is not available for the Central Valley. However, source information has been obtained for the Bay Area. The conclusions also may apply in the Central Valley, with the caveat that the Bay Area does not receive significant amounts of diazinon in rainfall as appears to occur in the Central Valley. Confirmatory studies are needed to verify that the Bay Area conclusions also apply to the Central Valley.

The primary source of diazinon and chlorpyrifos in Bay Area creeks is urban stormwater runoff. Samples from urbanized areas in Alameda County indicated that residential areas were a significant source, but runoff from commercial areas also may be important. It is not known what portion of the diazinon and chlorpyrifos found in creeks is attributable to use in accordance with label directions versus improper disposal or over application. However, a preliminary study of runoff from residential properties suggests that concentrations in some creeks may be attributed to improper use.

Novartis, the Registrant for diazinon, completed a diazinon probabilistic risk assessment for the Central Valley. Little data were available for the Delta, and

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concerns exist over the peer review the document received prior to release. The risk assessment suggests that the greatest impacts are likely to occur in water courses adjacent to sources such as orchards. Lower concentrations are predicted in main stem rivers. The report predicts that the Sacramento and San Joaquin Rivers will experience acutely toxic conditions to 10% of the most sensitive species, 0.4 and 11.6% of the time in February, respectively, the period of most intensive diazinon off-site movement. Novartis concludes that the risk of diazinon alone in the Sacramento-San Joaquin River Basin is limited to the most sensitive invertebrates, primarily cladocerans. The report notes that cladocerans reproduce rapidly, and their populations therefore are predicted to recover rapidly. The report also predicts that indirect effects on fish through reductions in their invertebrate prey are unlikely, as the preferred food species are unaffected by the diazinon concentrations observed in the rivers. The study recommends, however, that the population dynamics of susceptible invertebrate species in the basin be evaluated, along with the feeding habits and nutritional requirements of common fish species.

Identification of diazinon and chlorpyrifos in agricultural stormwater and irrigation return water and in urban stormwater runoff has resulted in the CVRWQCB including the Sacramento and San Joaquin Rivers and the Delta estuary on the CWA Section 303(d) list as impaired. The listing commits the CVRWQCB to develop a TMDL for each constituent.

5.4.3 Predominant Uses of Diazinon and Chlorpyrifos

Diazinon and chlorpyrifos are predominantly used as orchard dormant sprays, for growing season applications to orchards and other crops, and for urban structures and landscapes.

- **Orchard dormant sprays.** The application of diazinon during winter as an orchard dormant spray for stone fruits and almonds is widely practiced in the Central Valley (approximately half a million acres) to control many highly destructive insect and mite pests.

- **Growing season applications to orchards and other crops.** Chlorpyrifos is used in insect and mite control during the growing season (March through September), with major uses on cotton, alfalfa, citrus, and walnuts.

- **Urban structures and landscapes.** Diazinon and chlorpyrifos are used by professional pest control personnel and homeowners to control destructive insects, (termites and wood-boring beetles), as well as nuisance pests (ants, fleas, cockroaches, and spiders).

Diazinon and chlorpyrifos are predominantly used as orchard dormant sprays, for growing season applications to orchards and other crops, and for urban structures and landscapes.

5.5 APPROACH TO SOLUTION

5.5.1 Priority Actions

The CMARP will perform monitoring using both EPA standard bioassays and ecologically important local species to screen for and to determine the temporal and spatial extent of toxicity. This monitoring should be coupled with chemical analysis and the TIE procedure to conclusively identify the chemicals causing toxicity. Once chemicals are identified, follow-up studies should be undertaken to determine their concentration, duration, and frequency in surface water and also to ascertain their sources and fate. This information should be analyzed in a risk assessment fashion to help predict likely ecological significance of exceedances.

When chemicals are detected in surface water at concentrations that may affect beneficial uses, CALFED can help by facilitating the development of corrective actions. These actions should include development of water quality targets, development of MPs to control off-site movement, financial support to help implement the most cost-effective methods, and monitoring to evaluate MP effectiveness once implemented.

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DPR regulates the sale and use of pesticides but does not regulate cleanup of contaminated sites, which is the jurisdiction of the SWRCB and the RWQCBs. DPR and the Boards coordinate these responsibilities under a management agency agreement (MAA), as described later. The role of CALFED should be to use its combined state and federal authority, expertise, and resources in a coordinated effort with both the regulated and regulatory communities in order to help develop a comprehensive pesticide monitoring program. When chemicals are detected in surface water at concentrations that affect beneficial uses, CALFED should help to develop and fund the scientific studies in order to evaluate ecological significance and the preferred management methods to control off-site movement. Pesticide regulation will remain the responsibility of the agencies with regulatory authority.

A two-pronged action approach to pesticides is proposed. First, a comprehensive bioassay and chemical monitoring program in the Central Valley and estuary should be performed as a part of the CMARP. Second, the analysis for the two insecticides presented in this report (diazinon and chlorpyrifos) should be used as a template for further evaluation of these compounds, as well as for the identification and control of other toxic pesticides.

A two-pronged action approach to pesticides is proposed.

It is proposed that CALFED support the existing regulatory agencies functions (listed below) to determine and correct toxicity associated with pesticide use:

- Verify initial reports that a pesticide is causing toxicity.

  - Confirm toxicity
  - Verify chemical analysis
  - Evaluate TIEs

- Establish use patterns.

- Implement corrective actions.

  - Establish water quality targets and typical points of compliance
  - Develop MPs and public education and outreach programs
  - Support implementation of MPs
  - Evaluate implementation of MPs
  - Monitor water quality for achieving water quality targets
  - Reevaluate corrective actions as necessary

Proposed corrective actions should be consistent with existing regulations and management agreements. The general actions that are required to begin to resolve this water quality problem include (1) establishment of interim and long-term targets (quantitative response limits and water quality objectives, respectively), (2) development and demonstration of cost-effective MPs that can be implemented to meet the targets, (3) completion of studies to determine potential ecological impacts, (4) monitoring to more fully describe existing conditions and evaluate the effectiveness of MP implementation, and (5) establishment of mechanisms to ensure that MPs are implemented. CALFED staff will monitor progress made in these efforts and will periodically issue progress reports.

Proposed corrective actions should be consistent with existing regulations and management agreements.

Water Quality Criteria

The DFG has developed interim diazinon and chlorpyrifos hazard assessment criteria to protect fresh water aquatic life, using the standard EPA criteria development process. Final hazard assessment criteria were not recommended, as several data gaps were identified in the toxicological literature. Studies should be undertaken to fill these gaps. Once completed, DFG should be requested to use the information and calculate a final diazinon hazard assessment criterion. CALFED has agreed to fund the remaining portion of the study in order to establish a technically justified numerical goal. It is proposed that CALFED should fund work at both DPR and the SWRCB to convert the hazard assessment criteria into quantitative response limits and water quality objectives.

Development of Agricultural Management Practices

Development of agricultural MPs to keep orchard dormant spray insecticides on farm and out of surface water is just beginning. The work of the DPR, UC Integrated Pest Management, the Registrants, and others are described below under "Existing Activities." The work of each group is too preliminary at present to ascertain whether any of these actions might be successfully implemented to reduce diazinon and chlorpyrifos concentrations in surface waters to non-toxic levels. No work has yet begun on evaluating possible irrigation return water pesticide control actions.

Once preferred MP options are identified, funding should be sought for their field evaluation. At a minimum, the field testing should ascertain the amount of pesticide reduction achieved under varying Central Valley orchard conditions, whether the reductions would meet water quality objectives, and the cost per acre to the farmer to implement the practice. CALFED presently is funding research at UC Davis to investigate alternatives to traditional uses of organophosphate insecticides in agricultural pest management systems, which will contribute to development of agricultural MPs. CALFED also is funding the Community Alliance with Family Farmers, Biologically Integrated Orchard Systems (BIOS), which develops methods to maintain pest control with minimal use of pesticides. MPs could be distributed through education and outreach programs.

CALFED presently is funding research at UC Davis to investigate alternatives to traditional uses of organophosphate insecticides in agricultural pest management systems, which will contribute to development of agricultural MPs.

Future costs of MP development should be shared with other agencies to help maintain cost effectiveness in order to realize mutual and multiple benefits associated with widespread implementation of appropriate MPs. It is proposed that CALFED evaluate the feasibility of supporting pollutant trade-off programs.

Development of Urban Management Practices

Finding diazinon and chlorpyrifos in urban runoff prompted the formation of an Urban Pesticide Committee (UPC). The UPC is an *ad hoc* committee formed to address the issue of toxicity in urban runoff and wastewater treatment plant effluent due to organophosphate insecticides, in particular diazinon and chlorpyrifos. The UPC is composed of staff from the EPA, SFRWQCB, CVRWQCB, DPR, Novartis, Dow Agro Sciences, municipal stormwater programs, the Bay Area Stormwater Management Agencies Association, county agricultural commissioners, wastewater treatment plants, UC, and consultants. The members of the UPC are committed to working in partnership with the various stakeholders to develop effective measures in order to reduce the concentrations of organophosphate insecticides in urban runoff and wastewater treatment plant effluent. In addition to monitoring the effectiveness of these actions, a draft strategy for pesticide toxicity reduction includes the following:

Finding diazinon and chlorpyrifos in urban runoff prompted the formation of an Urban Pesticide Committee.

- Education and outreach programs by which MPs could be distributed to pesticide users in the general public.
- Education and certification changes for commercial applicators to ensure that pesticides are applied properly.
- Improving the regulatory tools of state and federal agencies.
- Adherence to prescribed MPs by public right-of-way and municipal facilities.

CALFED has funded several projects to begin development of MPs in order to reduce off-site movement of pesticides in the urban arena via stormwater. On another front in the urban arena, DPR has completed a study that identified potential sources of pesticides in sanitary wastewater. Pesticides in sanitary wastewater are treated only partially before being discharged to surface water. Their presence in wastewater may indicate a shift from citizens' dumping unused pesticides into storm drains to citizens' dumping these pesticides into the sewer system.

Evaluate Implementation of Management Practices

The pesticide effort is still at the early stages of MP development. However, once MPs are developed, it is proposed that CALFED begin discussions with both the regulatory and regulated communities about the most efficient methods of implementing the urban and agricultural MPs. CALFED should consult with DPR and the UPC concerning the results of the MP implementation evaluation to determine whether additional MP efforts are needed.

5.5.2 Information Needed

Biological surveys should be undertaken to determine the ecological significance of toxic pulses of diazinon. In-stream monitoring should be conducted to assess the impact of diazinon pulses on local aquatic communities. The Novartis diazinon ecological risk assessment predicts that impacts on sensitive invertebrates will occur but that population recovery will be rapid. No indirect food chain effects on larval and juvenile fish are predicted, as these animals were assumed to be capable of switching to an alternate food source.

In-stream monitoring should be conducted to assess the impact of diazinon pulses on local aquatic communities.

Detailed ecological studies are needed to ascertain whether invertebrate populations levels decrease and how long it takes for recovery to occur. These studies should target those areas of the watershed where monitoring has indicated that the most severe impacts might occur. The studies also should consider the